

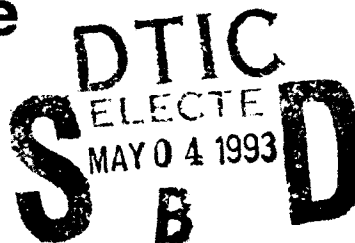
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Research Product 93-06

# Concept Formulation Process Aid for Trade-Off Determination

## User's Guide



93-09364



72 pf

March 1993

STRICOM, Orlando Field Unit, Florida  
Training Systems Research Division

U.S. Army Research Institute for the Behavioral and Social Sciences

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**EDGAR M. JOHNSON  
Acting Director**

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Human Resources Research Organization

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**Research Product 93-06**

# **Concept Formulation Process Aid for Trade-Off Determination: User's Guide**

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**Training Simulation**

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## FOREWORD

One problem faced by the military is determining how much simulation is necessary to meet training objectives. One issue in this complex problem is that the capabilities for simulating reality are increasing on an annual basis. Another factor is that the effectiveness of the training program is directly related to the instructional quality of the simulator. A third issue is that techniques for behavioral analysis that identify required features for training devices exist but are infrequently used. In addition, information on the cost-effective use of training devices in courses of instruction is sparse. The development of models, databases, and techniques addressing these issues will support the design, fielding, and use of advanced training technology. The potential effect on the U.S. Army will be to reduce the cost of fielding training devices and, at the same time, increase instructional effectiveness.

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Simulation, Training, and Instrumentation Command (STRICOM) joined efforts (Memorandum of Agreement on Advanced Technology for the Design of Training Devices, 1991) to investigate and develop models, databases, and analytical techniques that could support the design of advanced training technology. ARI work was performed under the task entitled Advanced Technology for the Design of Training Devices and Simulators.

STRICOM has maintained partnership in the development and evaluation of this concept formulation process aid prototype. The concept formulation process aid (CFP-Aid) provides a basis for supporting the integration of behavioral and engineering data, knowledge, and expertise in training device design. Final product and user evaluation briefings were held in December 1991 and July 1992, respectively. Managers from STRICOM's Research and Engineering Management Division participated in both briefings. STRICOM management is considering directions for application and further development.



EDGAR M. JOHNSON  
Acting Director

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CONCEPT FORMULATION PROCESS AID FOR TRADE-OFF DETERMINATION:  
USER'S GUIDE

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CONCEPT FORMULATION PROCESS AID FOR TRADE-OFF  
DETERMINATION: USER'S GUIDE

Introduction

Simulation-based training systems are complex training programs that use training devices to simulate critical aspects of tasks. These training devices are designed to support the acquisition of specific content-domain skills and knowledge. Each training device has to be designed to support a program of instruction for tasks performed on a particular weapon system. The training device specification is developed as a part of the overall acquisition process. The acquisition process structure is prescribed in Regulations and Standard Operating Procedures documents (AR 71-9, 70-1, STRICOM SOP 66). This prescribed structure details what has to be done in terms of meetings, decision points, and paperwork. What is not specified is the information that should be used and the mechanisms for conducting required trade-offs to define training simulations or training devices. These aspects are addressed by professional training, on-the-job training, and the institutional expertise residing in the various responsible organizations.

The Concept Formulation Process Aid (CFP-Aid) software is a prototype decision aid that supports the Trade-Off Determination (TOD) Phase of the Training Device Concept Formulation Process (CFP). The Trade-Off Determination Phase identifies the tasks and functions that the training device must address in the training program. It produces a preliminary specification of training device alternatives for further analysis in later phases of the concept formulation process. The aid is designed to assist the designer in proceeding systematically through the elements of the trade-off determination.

The purpose of this report is to provide a sufficient overview of the CFP-Aid for someone that already understands the CFP phases to apply the system. This section of the report presents an overview of the CFP-Aid software, its goals, the software development environment, descriptions of terms used, and a description of analyses available in CFP-Aid. This is followed by a section entitled "Getting Started" that explains how to install the system, how to start and stop the system, and some general information about interacting with the system. The third section provides an overview of how to use the system, and has information about what the system is doing to support the process. The last section is entitled "Program Menus" and presents a detailed overview of the program menus with examples of what each option and feature will do. This section also contains information about aspects of the system that are not completely implemented and some common problems that may arise and how to correct those problems.



## Goals of CFP-Aid

The CFP-Aid was designed to aid the user in meeting the following goals.

- Selecting and reviewing training requirements.
- Identifying required instructional features and fidelity levels.
- Assisting the user in cost, effectiveness, risk, and schedule analyses.
- Documenting applied requirements and analysis results.

The CFP-Aid functions addressing each of these goals are briefly discussed below.

Select training requirements. CFP-Aid helps you select training requirements by direct entry of required tasks or functions; by selection of training requirements from a master list of functions; or through the identification of training requirements based on the identified Military Occupational Specialty (MOS), Additional Skill Indicator (ASI), and Special Qualification Identifier (SQI) as per Army Regulation 611-201 (enlisted) and 112 (Warrant Officer). (The Officer organization of specialties is more varied and those task/functions should be selected directly from the task/function list.) The selected training requirements can be reviewed, extraneous requirements can be deleted, or new requirements added.

The functions database is developed to be cumulative. That is, the more the aid is used and the more functions are added, the more useful it becomes. The data are organized under MOS, ASI, and SQI links to task/functions in order to ease access and use identified relationships. Continued use will create additional functions linked to additional MOSs, ASIs, and SQIs; and presumably those functions will also be linked to device features. This will make the selection or identification of training requirements easier and the aid more valuable to the developer.

Examine training requirements. The system helps organize and examine training requirements by allowing you to specify and link requirement categories and cues to functions or tasks. The organization of training requirements will help you evaluate the specific simulation requirements for the candidate device.

Recommend effective features. The aid will help you (a) identify instructor support features through the research-based rules incorporated into the system and (b) identify required fidelity levels for visual and motion characteristics (other

fidelity dimensions can be added later). The system links requirements to candidate system component alternatives.

Assist in cost, risk, and schedule analysis. The aid helps you evaluate component cost, effectiveness, risk, and schedule factors by providing spreadsheets and formulas, and providing tables of the analysis results. Graphs and table displays generated by the system help you build system alternatives from components you identified and selected with system help. Similar displays are available at the training device system level to specify whole system alternatives.

Document requirements and analysis results. The documentation function provides a trace or audit trail of your selections and analysis results. The final results are organized in outline form which may be printed or saved as a text file. The text file can then be edited using word processing software.

### Software Development Environment

The software development environment under which CFP-Aid was developed is the GURU (Micro Data Base Systems, Inc., 1991) development system. The GURU development system is an integrated software environment which includes data bases, spreadsheets, graphics, expert system shell, text processor, and communications. GURU includes a fourth generation programming language for software development. The CFP-Aid software operates within GURU's interpretive environment.

### Definition of Terms

To use the CFP-Aid effectively, it is first necessary to become familiar with several terms that describe elements of the analyses performed by the aid. The terms are presented in the approximate order in which you will encounter them, and are briefly discussed below.

Project. A project is the training device project, and represents a collection of data files that contain the information used in the CFP-Aid that relate to a single trade-off determination.

Task. A task is the smallest complete activity that performs a meaningful portion of a job. An example of a task is "Clear the M-240 Machinegun." Tasks are often used as the basis for training requirements. However, a complete task list is seldom available, and when available may be too detailed for the TOD. Consequently, the CFP-Aid is also designed to operate at the function level.

Function. The function is a common element or activity from a collection of tasks, that may address part or all of those

tasks. One example is "Weapons and Emergency Procedures." The critical commonalities for these tasks are that they are all procedural, require a series of steps, and require a high degree of proficiency. Analysis of the function will produce the same training device requirements that analysis of the individual tasks would.

Requirement category. The requirement category is the category of information that is required to perform or initiate a task or function (e.g., normal engine operating noise or force feedback on controls). Requirement category is also referred to as a cue. Cue and requirement category are used interchangeably in CFP-Aid.

Instructional feature. An instructional feature is a training device capability that enhances or improves the efficiency of a training session. One type of instructional feature helps an instructor manage, organize, or plan training activities. Another category of instructional feature provides support for monitoring student performance. The third category alters the task environment in order to improve the students skill acquisition.

Fidelity issue. A fidelity issue is a group of fidelity dimensions (e.g. visual resolution, texture, content, field of view, etc.) which training devices use to present cues or allow responses with greater or lesser realism. The currently implemented fidelity issues address **visual displays** or **motion systems**.

Component. A component is any major part of a training device that represents an approach to addressing a needed fidelity issue. For example, certain levels of visual resolution, texture, minimal field of view, and visual content may be required for a set of tasks or functions. These fidelity requirements may be met by helmet mounted display, a partial dome, or a full dome. These three options would each become the visual component of a training device. The CFP-Aid considers the components that perform a similar function to be in the same family (e.g. visual). Components within the same family may differ according to how well they address a fidelity issue. Other components may be required to support the instructional features of the training device (e.g. an Instructor Operator station).

System. A system is a collection of components (one from each family) that comprise a complete training device alternative. A combat mission training device alternative may have a helmet-mounted display, a state-of-the-art computer-generated imagery system, and a six degrees of freedom motion system. That configuration would be one alternative system that could then be analyzed.

## Description of Analyses

Task/function selection. The aid has a master list of tasks with specific tasks linked to MOS, ASI, and SQI. When you select the MOS, ASI, and SQI the system uses the links to identify all the linked tasks and functions. You may also add new tasks or functions and specify new or additional links. Linking or relating MOS, ASI, and SQI, to tasks and functions (and cues and components) allows the system to bring information to you for the new TOD process. In this way the system can provide a more detailed level of analysis earlier in the process. Obviously, you can override the system links or recommendations, and leave their imprint on the information maintained in the system for the next user.

Instructional features recommendations. This analysis uses the expert system feature of GURU. Recommendations are made for each function based on function data. The expert system operates in three modes:

Automatically based on preselected and stored data - The rule base system uses the existing database data to generate instructional feature recommendations.

Automatically with user confirmation - The rule base system presents the data for confirmation **before** each rule executes.

Manually based on user-supplied data - The rule base system presents questions designed to elicit the data needed for the rules to execute.

The aid can also provide a justification for the recommendations made. This is a host environment feature that serves to explain the logic used to identify or recommend the instructional features.

Fidelity recommendations. As noted above, the aid currently contains rule bases for identifying and recommending motion and visual components. The structure of the aid is capable of housing additional rule bases as they are developed. Fidelity recommendations are made for each function based on system function data. The fidelity rule bases also work with the expert system in the three modes (described above): automatically based on preselected and stored data, automatically with your confirmation, and manually based on data you supply. The aid will also provide justification for the recommendations made based on the rules used.

Component cost, effectiveness, risk, and schedule (CERS) analysis. Each of the factors in component CERS can be examined separately in a graph and in a spreadsheet. You can view and

edit the estimates and weights for each factor on the spreadsheet.

System CERS analysis. The system CERS analysis is combined over components. The costs are summed across component, the effectiveness considers both fidelity and instructional features, risk is combined as probability, and schedule is combined using PERT assumptions. You can edit the estimates and weights for the system CERS in a spreadsheet. You can view the results in both graphic and tabular form.

Outline generation. As you use the aid, the results of each analysis are stored in one or more sections of an outline file. The CFP-Aid will present questions every time an analysis is performed that would alter the material in the outline. These questions focus on whether to add the material into the outline as alternatives or replace previous information. New results can replace older results, so that the outline always represents the most recent results, or they may be added to older results, so that the outline represents the history of analyses. The outline can provide an audit trail of your work on the project. The outline can be printed or saved as a text file for later editing in a word processing system. Care should be practiced not to shift modes in the middle of projects, to ensure that an audit trail is not lost in replacing information from recent analyses.

## Getting Started

### Hardware Requirements

The CFP-Aid software is designed to operate with the MSDOS Single User GURU software Version 3.0 (MDBS, Inc., 1991) on the standard IBM PC/XT/AT or compatible computer with a hard disk drive and an EGA or VGA color or monochrome monitor. The computer must have at least 640K bytes of RAM and 5 megabytes of room on the hard disk for the GURU software and full operation of associated programs. The CFP-Aid software responds to keyboard input as well as input from a two- or three-button mouse. (any standard MS-DOS mouse should work with GURU, if problems are found MDBS Inc. should be contacted for instructions.) These input options are available throughout the prototype system, with instructions for exclusive keyboard entry where required.

### Configuration Requirements

When the GURU software is installed on the computer the INSTALL procedure will make changes to the AUTOEXEC.PAT and CONFIG.SYS files in the root directory. The AUTOEXEC.BAT file will be changed to include the PATH for the directory containing the GURU programs. The CONFIG.SYS file will be changed to set the following default values:

BUFFERS=15  
FILES=50

These changes are required because the CFP-Aid needs at least 15 disk buffers and 50 files in order to operate. If you install GURU and the CFP-Aid manually, you should make these changes to the AUTOEXEC.BAT and CONFIG.SYS files. DOS procedures can be used to make any necessary changes to these files. Remember, if changes are made they will not go into effect until the system is rebooted. As with all data base applications third party disk caching software will enhance the speed of operation of CFP-Aid significantly. There are no known incompatibilities with any commercial disk caching programs (which use excess memory to store information that the program uses frequently in order to speed processing). If problems with disk caching software arise, we suggest you remove or disable the software and contact MDBS Inc.

### Installation

The CFP-Aid software comes on two 5-1/4" 1.2 MB disks or two 3-1/2", 1.4 MB disks. All of the instructions presume that you have installed the GURU software as directed by the GURU manuals. The following procedure will automatically install CFP-Aid on your computer:

1. Place disk 1 in a disk drive.
2. Make the drive you put the disk in the current drive by entering the drive letter and a colon. For example, if you put disk one in drive a:, you would enter the following:

a:

3. Start the install program by typing:

INSTALL c: \directory [NOTE: the space between the drive identifier and the specified directory is REQUIRED!]

where c: and directory are the drive and directory on which you wish to install the CFP-Aid. You must enter a drive letter, but the directory is optional. For example, if you enter:

INSTALL c: \CFP-Aid [NOTE: the space is REQUIRED!]

then the software will be installed on the C:\CFP-AID directory. If you enter "INSTALL c:" and you do not enter a directory, the software will create a directory labeled \CFP and install CFP-Aid on that \CFP directory.

The program will prompt you to put in disk 2 when required.

NOTE: The install program will overwrite any existing files on the target directory.

### Start Program Execution

To start program execution, use DOS commands to change to the \CFP directory, type the word GO, and press ENTER. The steps are:

1. Change to the \CFP directory.
2. Type GO and press ENTER. (The GURU logo will appear on the screen for a few seconds. The screen will clear and the first CFP-Aid Menu will be displayed.)

### User Interaction

There are several different ways to move interact with the CFP-Aid software. The arrows, ENTER, and ESC keys are one way to use the program. The arrow-keys can be used to move within menus. When a menu item is highlighted, press ENTER and the system will display an additional menu, list, screen, or perform the indicated function. The ESC key will always exit the current function or return to the previous menu. When entering or editing data, the tab key can be used to move through the data fields, and the left arrow will back-up through the fields. Using the backspace or the delete keys will erase entries a character at a time. Another way to use the program is to select menu items by typing the letter corresponding to the capitalized letter in the menu choice, without having to move to or highlight the item. Alternatively, a mouse may be used to move through the menu selections and to move the cursor on the screen. The left button of the mouse is the ENTER function and is used to select items from the menu. Clicking on a command word in the main menu activates a pull-down menu. Clicking on an item in a pull-down menu displays an additional menu, list, display, or executes a process. The right button of the mouse is the ESC function and is used to back-out of menus and procedures. The middle button on the three-button mouse should be inoperative. Text or numbers must always be input in response to screen prompts by using the keyboard.

The menus and selections lists vary in one important way. All of the menus and ~~some~~ of the lists are simple selection functions, which means that as soon as an item is selected the program proceeds. However, some of the lists provide for multiple selection, which requires selecting the "done" item from the bottom of the list before the program proceeds to the next step. The multiple selection lists occur in logical places and should be readily apparent. When in doubt, check the last entry

in the menu or list. If the last entry is "done," multiple entries are possible.

### Using the Program

This chapter describes the use of the CFP-Aid program. The description begins with general instructions on working with projects. This is followed by sections on determining requirements; defining system components; analyzing Cost, Effect, Risk, and Schedule (CERS); and documenting the results of the analyses.

#### Working With CFP-Aid Projects

The term "project" is used to refer to a collection of data files that relate to a single Trade-Off Determination. You are required to create or open a project before you do any other analyses. This section tells you how to start new projects, open existing projects, save projects with a new name, and exit the program.

CFP-Aid uses master files and project files. Master files contain the start condition files and databases. The master files remain constant and are not changed during project work. However, you may add to and delete items from the master files by using the file maintenance procedures. Changes made to the master files change the start-up condition files and databases and impact on all future CFP-Aid projects.

Project files do change. Work on a project is accomplished interactively and interactive work on the project constantly updates and changes the project files. Changes are written to the project files as procedures are completed. Therefore, you may exit the program at any time. You do not have to close or save any files before exiting.

New projects. To start a new project:

1. Select **New** from the File menu.
2. Enter the Title for the project.
3. Enter the Project Description.
4. Enter the other requested information.

When completed, the new project is identified and all appropriate files are opened and ready to use. You may exit the CFP-Aid at any time. You can open the new project and continue work on the project at any time. The new project will remain in the system until deleted.



Opening Projects. You **Open** a project to continue work on an existing project. To open the project select **Open** from the pull-down menu under **File**. You may specify the project to open using either of the following methods.

1. Select **project** and then choose the project you want to work on from the menu that is presented.
2. Select **Enter key phrase** from the submenu and use the keyboard to enter the description of the project. The key phrase may be a portion of either the title or description for the project. The system will present you with a menu of all projects that contain the key phrase. Select the desired project from this list.

When completed, all project files will be the same as when you last used the project, and you may continue work on the project.

Project status. This function under **File** provides a first time record of the system activities that have been performed on the current project. It does not record how many times a system function has been exercised, the current status of files, or the completeness of the outcomes.

Saving a Project with a New Name. When you want to make some changes in project data or results, but also want to keep a copy of the current state, you must have two projects with different names. The **Save as ...** option under the **File** menu allows you to make a copy of the current project under a new name. It is important to recognize that the project files are updated whenever you make a change. Consequently, you must save the copy of the project before you make any changes. Project files may be copied to a new project name using the following procedure.

1. Select **Save as ...** from the **File** menu.
2. Enter the new title for the project.
3. Enter the new project description.

When you have completed these steps, the original project files will be copied to the new project directory, and the new project will be made the current. Any changes you make to the data or analyses at this point will involve the new project only and will not affect the original project.

Other functions. You can use the **delete** option in the **File** module to remove projects (and associated files) from your computer system. The **Print** option allows you to print selected files containing current project information.

Exiting the Program. When you select **Exit** from the File menu you exit the program and return to DOS. When Exit is selected all project files reflect the status of the project at that time. Subsequent work on the project begins with the existing information and analyses from the previous sessions.

### Determining Requirements

To design a cost-effective training device it is critical to know what kinds of activities are going to be trained using the device. The tasks or functions to be trained form the requirements for the training device. Characteristics of functions that affect training-device design include the following:

- Whether the functions are procedures, continuous control activities, or decision-making tasks
- The skills that trainees have when they enter training and the level of performance that must be attained using the training device.
- The specific information that the trainee requires to learn and perform the task.

The CFP-Aid can help you identify, define, and organize the functions that are required for training. In addition, the CFP-Aid uses the information about functions to make recommendations regarding the instructional features, fidelity levels, and components that should be included in the training device. The first few times you use the CFP-Aid, you will need to enter much of the information required by the system. However, as you use the aid more, you will be able to rely on information that is already in the system data bases, and the requirement for data entry will decrease substantially.

Selecting Tasks/Functions for MOS Training. Training devices typically address tasks or functions for a specific MOS (or a few at most). From the Requirements Module select the **Required Tasks/Functions** option; then the **Select from MOS** option. The program will then prompt you for the MOS, ASI, and SQI, as described later in the program menu section. The program will display all the functions associated with the selected MOS, ASI, and SQI for review. You may remove any of the functions that are not of interest by highlighting the item and selecting it. This is essentially a toggle function that can just as easily restore the item to the list. This function will be referred to as "deselecting" an item throughout the remainder of the manual.

If the tasks/functions of interest are not in the CFP-Aid data base, the information and links must be added to the system. First the **Requirements** module is selected, then the **enter/edit**

data menu item. Then add the new tasks and functions as necessary, as well as any associated ASIs, SQIs, MOS(s), and Cues. The add function automatically includes creation of links to any existing items. Once the information has been entered, it is a simple matter to use the list begin determining the training device requirements.

There are two special cases for which selection of functions from the MOS eases the process. The first case occurs when the training device will be used to provide training for more than one MOS. For example, when a maintenance trainer is to be used to train both organizational and depot maintenance or a weapons trainer will be used for both introductory and sustainment training. The second case occurs when the MOS for which the training device being designed is not included in the system data bases, but a similar MOS (or group of MOS with similar tasks or functions) is included. This case would occur if the MOS involved a weapon system that was under development, but the CFP-Aid included data about comparable jobs using existing weapon systems.

When multiple MOS are involved, functions may be selected by making several passes through the selection process. The same procedure is applicable if a single MOS with multiple ASIs or SQIs is involved. After the first pass, it is important to select the **Add** option (instead of **Start over**) so that tasks for each MOS are added to those that have already been selected. It is recommended that you review the selected tasks at each step of the process and eliminate any unwanted tasks. Otherwise, you may have a list with similar tasks from different MOSs, a situation that would make it difficult to determine which task to retain and which to eliminate. There is an alternative method that will allow compilation of tasks/functions for multiple MOSs. Simply select one of the MOSs, then use the **Select from Master List** to add to or remove from the list of tasks/functions until the list is complete.

When a training device is required for a new MOS (i.e., one that is not in the CFP-Aid data bases), the CFP-Aid can still be used. The first step is to select tasks from another MOS that are similar to those required in the new MOS. One way to select these representative tasks is to use tasks that apply to comparable equipment or are similar in function. For example, the new MOS may be for a pilot on a special operations forces helicopter, which may have the same weapon systems as the AH-64, a radar system similar to the AH-1, and emergency procedures based on the OH-58. To synthesize the tasks required to train the operator, first select the MOS for the operator of the AH-64, and eliminate all the tasks except the tasks that involve the weapon system. Then use the **Select from Master List** command under **Required Tasks/Functions** in the **Requirements** module. Include those tasks that are comparable to the new MOS tasks (as

done above for the multiple MOS example). When all the tasks have been selected, you may still need to define additional tasks or modify task data using the procedures described in the following sections.

Adding and Editing Task/Function Data. The previous section described how you can choose tasks/functions that were originally developed for one MOS to aid in the design of training for another MOS. Usually, it is not possible to determine all of the functions through this kind of comparability analysis. Even when functions can be identified in comparable MOSS, the functions in the target MOS may be different in many details from the comparable functions in the source MOS. In these cases it will be necessary to add functions, or to modify information about existing functions. Even when functions from the target MOS are available in the CFP-Aid data base, it is a good idea to review the information about each function to ensure that it is accurate and current.

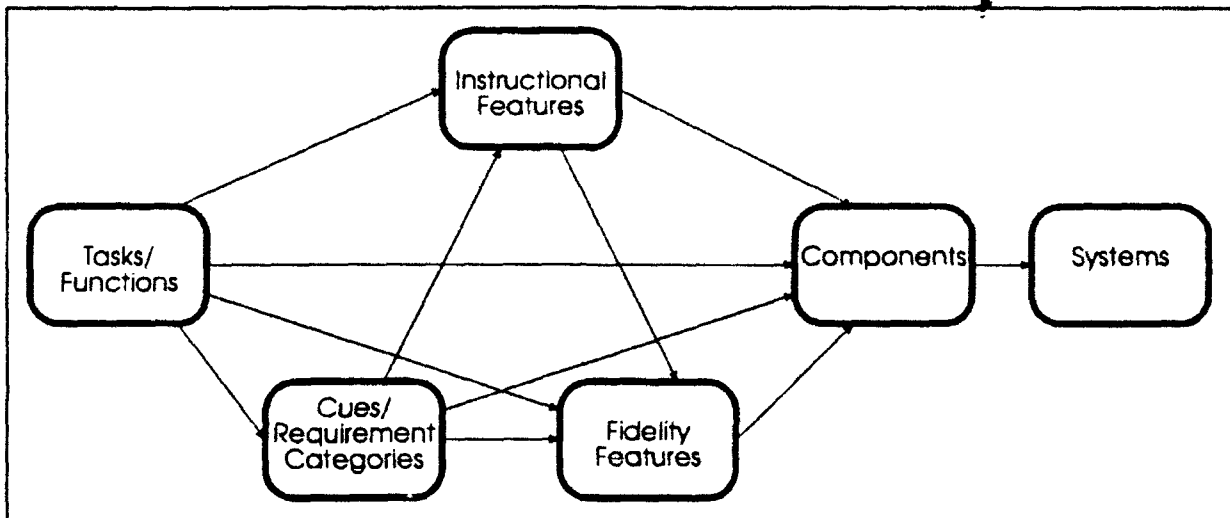
You may add functions or modify the data from old functions using the **Enter/edit Details** menu choice from the **Required Functions** menu. Changes to the master files can be made by choosing the **Enter/Edit Data** option from the **Requirements** menu. Details of the procedures for entering and editing data are described in the previous section.

Selecting Requirements Categories. The types of information and cues required to perform a function are major determinants of the capabilities required to train competent performance of the function. The direct links from functions to cues provide the first approximation of the requirement categories that should be considered. These requirement categories are generated by the CFP-Aid when you select the **Automatic Selection** option from the **Requirement Categories** menu.

After the CFP-Aid has selected the requirement categories, review the results to make sure that they accurately reflects the cues required for training. There are several instances in which you may want to add or drop cues from consideration. For example, a certain function may need to be performed under a variety of environmental conditions, such as day, night, smoke, battle conditions, and so forth. However, even though there are a variety of performance conditions, there may be fewer training conditions that require the use of the training device being designed. In other situations, it may be necessary to add cues to those automatically generated by the CFP-Aid. For example, the cues may have changed, due to equipment improvements, such as the replacement of single-purpose displays with multi-function video display. If you think that the cues that you added should be permanently linked to some of the functions, then edit the function data to add these links.

## Understanding Links

The elements of the CFP-Aid are associated by links as shown in Figure 1. For example, tasks are linked to requirement categories (or cues), instructional features, fidelity issues, and components. The existence of these links means that knowledge of the task may have implications on any of the four other elements to which tasks are linked. A particular task may require a certain kind of cue or have specific requirements for visual resolution, platform motion, or other fidelity issue. Similarly, the task may require that a specific instructional feature or component be included in any device that is used to train the task.



**Figure 1.** Links between elements of the CFP-Aid.

The types of links that have been included in the model provide it with flexibility that is required for the early stage of the design process at which the TOD is conducted. At the time the TOD is performed, tasks may be only partially understood, and requirements for device components must be determined using information from a variety of sources. The CFP-Aid contains four lines of reasoning that can be used to identify the need for a particular component. (a) Components may be linked directly to tasks; (b) components needs may be identified by considering the cues to which tasks are linked; (c) component needs may be derived from the fidelity requirements determined by one of the fidelity rule bases; and (d) component needs may be derived by considering the instructional features needed to train the task.

Whenever you add or edit a function, cue, or other information, you will need to consider the links between the information you are editing and other elements of the analysis. These links can be used by the CFP-Aid to help you, as well as

future users, to identify requirements for specific training-device components. To maintain the links between functions, cues, and components, you will often have to add new cues and components when you add new functions.

When you view the results of the instructional feature or fidelity rule bases, or of the component or system CERS, the results are displayed separately for the different incoming links. For example, the instructional features rule base can receive links from functions and cues (Currently, however, there is no rule base to process links from cues). The results for the instructional feature rule base will identify instructional features selected based on the cues from the instructional features selected based on the functions.

### Selecting System Components

Components are generally selected automatically, based on links from functions, cues, fidelity features and instructional features. The links from functions and cues are part of the function and cue data and are produced automatically when the functions and cues are selected. The links from instructional features and fidelity features require you to perform the appropriate instructional features or fidelity analysis, respectively. These analyses are preformed by a collection of expert system rule bases. Links from functions and cues to instructional features and from functions, cues, and instructional features to fidelity features are mediated by instructional feature and fidelity rule bases. Currently, these rule bases consider links from tasks only; rule bases to consider the other links may be added at a later date.

You may select components that were not linked to functions, cues, instructional features, and fidelity features, and you may deselect any inappropriate components produced by the automatic selection. The CFP-Aid will select any component that meets the requirements of one or more function, cue, instructional feature, and fidelity feature. Consequently, the CFP-Aid may select several components in each family. In order to reduce the effort required for evaluation, you should try to reduce the number of component candidates by eliminating components that are infeasible, unaffordable, or unacceptable for some other reason. The component CERS, described in a later section, will help you to eliminate unneeded, ineffective, costly, or risky components. However, you should be able to make some adjustments to the selected components using the **Select from master list** or **Review selections** options from the **Components** menu.

Exercising a Rule Base. The procedures for running an instructional feature or fidelity rule base are described later in this report. Basically, there are three ways that instructional feature and fidelity analysis can be performed:

automatic operation, automatic operation with confirm, and answer question. Automatic operation runs the rule bases using the data stored in the CFP-Aid data bases. If the existing data are insufficient, then the rule base will prompt you for any additional data that are needed. Automatic operation with confirm shows you the data that will be used by the rule base, and allows you to change the values of categorical variables. Numerical variables cannot be changed in this mode. In the answer question mode, all input data variables receive the value "unknown" before the rule base is run. The rule base will prompt for the values of all data that are needed for the analysis.

A particular rule base will only be run for tasks that are linked to that rule base. If you want to consult a rule base for a specific task that is currently not linked to the rule base, you must first add that link. The specific procedures used to add the required link involve the **enter/edit details** option under the **Instructional Features** or **Fidelity** menus.

#### Analyzing Cost, Effectiveness, Risk, and Schedule (CERS)

The CERS analysis provides measures of the value of components or systems. Initial analysis at the component level can compare different components within a single family. This analysis can be used to reduce the total number of component options that are being considered, and hence, the number of candidate systems that are being considered. System creation can be done automatically by the CFP-Aid, or you can manually define candidate systems from a master list of components. The system CERS aggregates the value of each component in the system to obtain an estimate of system costs and benefits.

Performing Component Analyses. You may obtain a summary of the cost, effectiveness, risk, and schedule implications for the components in any family by selecting the **overall** display, which shows a graph of each of the four factors. The factors are presented logically, with greater numbers indicating greater cost, increased effectiveness, greater risk, and longer schedules. The desire, naturally, is to minimize cost, risk, and schedule, while maximizing effectiveness.

The spreadsheet view of the data gives you the opportunity to get a more precise view of the numbers that are shown in the graph, to modify any of the individual input data, and to set some adjustment weights that can change the impact of several input values simultaneously. The adjustment weights should reflect assumptions of the analysis. For example, if you wish the component cost analysis to consider R&D costs only, then you should set the weights for other cost factors to 0.0. The adjustment weights also give you the capability to conduct sensitivity analyses. For example, you could examine the overall results if R&D were doubled for a particular component, or if the

schedule were compressed 50% by changing the weights for these factors.

Creating System Definitions. Automatic creation of candidate systems makes every possible combination of selected components, such that one component is selected from each family. Consequently, it is possible for automatic system creation to create thousands of system candidates, if there are many selected components for each family. For this reason, it is imperative that you reduce the number of components within each family as much as possible if you intend to create systems automatically.

In some cases, you may not be able to reduce the number of components. For example, you may want to investigate a wide range of system options, varying from options that include unsophisticated components in many families to options that are very sophisticated in many respects. The **select from master list** option from the **create systems** menu is designed for these cases. This option allows you to define candidate systems on a family-by-family basis.

Performing System-level Analyses. The factors of the system CERS are derived from the corresponding factors in the component analyses. System cost is obtained by summing the cost of the components included in a system. System effectiveness is obtained by finding the total number of tasks, cues, instructional features, and fidelity features that point to one of the components in the system. Risk is combined as a probability of failure; that is, the probability of system failure is the probability that one of its components will fail. Finally, schedule is combined assuming that component R&D activities are conducted in parallel; the overall schedule is the greatest of the component schedules.

The overall analysis presents a summary of the results. In this case, there is a single graph that combines measures of effectiveness (MOEs) for cost, effectiveness, risk and schedule. In this case, the MOEs are normalized so that a greater number indicates a better system. Thus, MOEs for cost, risk, and schedule are inversely related to the raw measures of these factors. As is the case with component analyses, the spreadsheets may be used to get a more precise view of the numbers that are shown in the graph, to modify any of the individual input data, and to set adjustment weights.

#### Documenting the Analyses

The Documentation Module is used to generate, print, and save project outlines.

Generating a New Outline. The outline is not automatically updated. The system generates the outline only when requested to



do so. Work on the project subsequent to the last time the outline was generated will not be reflected in the outline until a new outline is generated. To generate the outline select **Generate outline** from the **Documentation** menu. A new outline will be generated reflecting all current work on the project.

Printing the Outline. To print the outline select **Print outline** from the **Documentation** menu. The outline is printed on the printer. The printer must be connected and on-line prior to selecting **Print**. It may be more convenient to print the outline to a file instead of to the printer. This option will be quicker, and you may use a word processor to edit the outline before you print it.

### Program Menus

This section describes the program menus, beginning with the main menu. Each session with the CFP-Aid program begins and ends with this menu. There are information windows embedded in some of the menu selections that allow selection or de-selection of information, functions, variables, etc. The location of these windows are indicated and examples are provided in the following descriptions.

Menu items may be selected in three ways. First, a mouse may be used to highlight an item for selection with the mouse button. Second, the arrow keys may be used to highlight an item for selection with the enter key. Finally, the key corresponding to the capitalized letter in the keyword may be used to select the item.

The data or information presented in the screen or menu representations shown here were constructed only for demonstration purposes to exercise the prototype system. The information will become more complete and real world when users perform analyses for actual projects in support of the training-device development process.

Some planned program functions are not implemented in this version, although the menu selections are present in the system structure. These functions are indicated by the initials TBD, meaning that the way the function will work is To Be Determined and has not been programmed in this version of the CFP-Aid.

|                                 |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| Concept Formulation Process Aid |              |            |          |               |
| File                            | Requirements | Components | Analyses | Documentation |

The main menu is presented at the top of the screen and provides one-word descriptors for the five modules. For a new project you will normally work in each of the modules while moving from left to right through the menu. Each of the five

modules is described in detail and in the order they appear in the menu. Each menu is followed by a detailed explanation of the function of each menu item. The five modules and their functions are briefly described below.

- File** The File module is where you specify the project you wish to begin work on or select the project you wish to continue work on. The File module lets you easily change from one project to another or to a different version of a project. It allows you to save a copy of a project using a new name, delete a project from the system, print rule base data and data bases, and exit from the program.
- Requirements** The Requirements module helps you define the goals of the training device being designed. It is used to identify tasks or functions that are to be trained by the device, to select the perceptual cues and response options that are required for training the tasks and functions, and to document the reasons for simulation.
- Components** The Components module assists you in specifying the Instructional Features and Fidelity required by the tasks/functions. Also, it allows you to specify the system components for consideration.
- Analyses** The Analyses module allows you to compare the cost, effectiveness, technical risk and schedule (CERS) for specific components and systems based on your input. It also, generates systems from selected components.
- Documentation** The Documentation module generates an outline to help you document your work with the CFP-Aid system, and to provide information to the TOD.

#### File Menus

|                                 |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| Concept Formulation Process Aid |              |            |          |               |
| File                            | Requirements | Components | Analyses | Documentation |

The File module is the first module used. It is where you specify a new project to work on or select a project for continuing work. The system allows you to work on more than one project or more than one version of a project. The File module lets you open a project, start a new project, or exit the system at any time. When you open a project or name a new project, that project becomes the current project. The current project is the

only project affected by your input in the Requirements, Components, and Analyses modules. There is no requirement to close or save a file as the current project files are all automatically closed and saved when you exit the system or open a new project. The project file will be kept, reflecting the status of the file when last worked on, until you delete the project. When a project is deleted, all the working information associated with that case is removed, therefore care should be taken when using this option. The master file data can only be deleted on a record by record basis.

| Concept Formulation Process Aid   |              |            |          |               |
|---|--------------|------------|----------|---------------|
| File  | Requirements | Components | Analyses | Documentation |
| New<br>Open<br>Save as ...<br>pRoject status<br>Delete<br>Print<br>Exit |              |            |          |               |

#### New

Select New to begin work on a new project. When you select New the program presents a database screen. The first active field is for the new project title. The title may be up to 30 characters long. There is no error check on matching titles.

Project title: \_\_\_\_\_

When you type in the title and press ENTER, the cursor moves to the project description line. The description may be up to 60 characters long.

Project description: \_\_\_\_\_

After you type the project description and press ENTER, the program prompts you to enter the required number of people trained on the projected training device in one year, as well as several other parameters used by the CFP-Aid.

Enter required number of trainees per year: 100

Anticipated weight of cost analysis: 1.00

Anticipated weight of effectiveness: 1.00

Anticipated weight of risk analysis: 1.00

Anticipated weight of schedule analysis: 1.00

Project lifecycle (years): 20

Standard training adjustment rate: 0.10

The weights are used to adjust the importance of the four factors in the combined cost-effect-risk-schedule analysis. The system will accept and use any number (no error check). However, it is recommended that a scale of 0 to 1 be used. Assigning all weights the same values requires the system to treat all factors equally. The project lifecycle is used in the cost analysis portion of the program. The standard training adjustment is not currently used in the program and can be skipped. In future versions this adjustment would be used to set the exponent for a hypothetical transfer function, which would be used to calculate the amount of transfer from the device to the actual equipment. To accept the default values, press ENTER for each field. When you have completed entry of the required information, the name and the description of the new project will be displayed on the bottom of the screen and the pull-down menu will reappear. This indicates the new project is the current project and you can begin work on it.

---

**Open**

Select Open to resume work on an existing project. When you select Open a two-line menu is added to the screen:

Select project  
Enter key phrase

**Select project**

Lists all the existing projects so you can select the project you wish to work on. The selected project becomes the current project.

**Enter key phrase**

Allows you to select a project by entering the title or a descriptive label for the project.

The system will display a list of all the projects that have the entered **word** or **phrase** in the title or description. You then select the desired project from the list.

---

**Save as...**

Select this item to file a complete copy of the project you are currently working on, in its current configuration, with a new user-specified title and description. This procedure is particularly helpful when you want to keep one version of the project in its present configuration and also continue to make changes to the project. When you save the project with a new name and description, the project with its new name becomes the current project. The project with its previous name is still available in the system and can be opened and modified at any time by using that previous name. The previous project files are in the same state they were when this function was selected.

---

**Project status**

Select Project status to view a list of CFP-Aid modules showing which parts have been completed and those which have not for the current project. Items marked completed indicate you have entered that process and performed some work on the project. It does not indicate the degree of completeness. A sample is shown here:

|                              |                |
|------------------------------|----------------|
| Project status               |                |
| Title: Xxxx                  |                |
| Date: 10/11/91               | Time: 11:04:10 |
| ✓Required tasks/functions -- | Completed      |
| Requirements categories --   | Not completed  |
| . . . . .                    |                |
| System CERS analysis --      | Not completed  |

The project status display will remain on the screen until you press ENTER.

---

**Delete**

Select Delete to remove a project file from the system. The screen lists all the existing project titles so you can select the project or projects to delete. A selected item may be deselected by clicking again on an item

selected for deletion. When you select Done on the menu the program will ask for confirmation prior to deleting the project files. When you confirm you want the selected project file or files deleted, all the selected files are permanently deleted from the system. Please note that when a project listing is deleted all of the working project files will be deleted. However, none of the changes or additions to the master data files will be lost.

---

**Print**

Select **Print** to get a menu accessing the available print functions. This supports print-out of the data that can be used in the analyses. The options refer to the master files, and will print out all of the data in the selected database.

List of Projects  
Function databases  
Cue databases  
Simulation Checklist  
if Rulebase data  
fiDelity rulebase data  
coMponent databases  
docUmentation databases  
All  
doNe

**List of projects**

This process prints a list of all the existing projects. The printed list shows the project title, the date created or last modified, and the description.

**Function database**

This selection prints a list of the task/function detail contained in the function data base. The listing will include the task/function description, data describing the task/function, and associated cues and components that are linked to the task/function.

**Cue database**

This selection prints the cue source data base. The listing includes the description of the cue and associated components.

|                               |   |
|-------------------------------|---|
| <b>Simulation checklist</b>   | This selection prints a list of the questions from the simulation checklist along with priority indicator and rating data.  |
| <b>IF rulebase data</b>       | Prints instructional feature rule base data for all task/functions in the master database. For each instructional feature in the master data base that contains actual data or links, the system prints the instructional feature with the associated rule base, rule base questions, and current data for each question. |
| <b>Fidelity rulebase data</b> | Prints the fidelity rule base data contained in the master task/function file. For each function in the master data base that contains actual data or links, the system prints the function with its associated component family (e.g., MOTION), fidelity rule base questions, and current data for each question.        |
| <b>Component databases</b>    | This selection prints a list of the components in the data bases. The listing includes the description for the component and the family (e.g., VISUAL) associated with each component.  |
| <b>Documentation database</b> | Prints the master Trade-Off Determination document outline template.  |
| <b>All</b>                    | Prints all the above.   |
| <b>Done</b>                   | Returns to previous menu  |
| <hr/>                         |   |
| <b>Exit</b>                   | Quits CFP-Aid program and returns to DOS. Exit closes and saves all files using the name provided when the project was first started or saved (see above).  |

To exit the File menu, press ESC or the right mouse button. This will return you to the top level menu.

## Requirements Menus

| Concept Formulation Process Aid |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| File                            | Requirements | Components | Analyses | Documentation |

The Requirements Module helps you select the Tasks/Functions, identify the Requirement Categories, and document reasons for simulation by using the Simulation Checklist.

| Concept Formulation Process Aid |   |            |   |               |
|---------------------------------|---|------------|---|---------------|
| File                            | Requirements  | Components | Analyses  | Documentation |
|                                 | required Tasks/functions<br>requirement Categories<br>Simulation checklist<br>Enter/edit data |            | Select from MOS<br>select from master List<br>Review selections<br>enter/eDit details |               |

**Required Tasks/Functions** This process allows you to specify or select tasks and functions by identifying the training device requirement Military Occupational Specialty (MOS), Additional Skill Identifier (ASI), and the Special Qualification Identifier (SQI); by selecting from the master list of tasks. You may review your selection at any time and deselect undesired tasks and functions.

**NOTE:** When you select a procedure already performed for the current project the system alerts you and gives you three options; Add, Start Over, or Cancel. You select one of the options or respond by entering an A for Add, an S for Start over, or a C for Cancel. You can also select one of the options using the arrow keys to highlight an option and pressing ENTER or by using a mouse. Add means you want to add to the previous work on the project. Start over means you want to start the current procedure over from the beginning. Start over deletes previous selections in the current process and returns to default status. Cancel returns you to the previous menu.

When you complete a procedure, the system asks if you want to "Commit these results to the outline?" There are three options: No, Add, and Replace. Select No if you do not want the work on the project during the just-completed procedure appended to the outline. Select Add if you want to add material to the existing material. E.g., tasks selected would be added to outline sections along with previous task outline entries. When you specify Add, the program keeps a record of all decisions made and their outcomes. If you select Replace, the existing task outline sections are erased before adding to the outline. In all cases the material is entered in the outline file with a time/date



stamp, so that the outline may serve as an audit trail or record of data collection and analysis.

---

**Select from MOS**    Select from a list of MOS: (E = Enlisted, O = Officer, W = Warrant Officer). Selecting an MOS begins the derivation of functions by limiting the options to related ASIs and SQIs. Once the ASIs and SQIs are selected (at least one of each must be selected) a list of related or derived functions is presented. For example:

— MOS Choices —

93B (E) - Aeroscout observer  
15A (O) - Aviation general  
15B (O) - Aviation, combined arms operations  
15C (O) - Aviation tactical intelligence  
.  
.  
.  
Previous Menu

When you select the MOS a list of the ASIs related to the selected MOS is presented.

— Additional Skills —

00 (E) - No additional skills  
4A (E) - Reclassification training  
P5 (E) - Master fitness trainer  
Previous Menu

When you complete the selection and exit the ASI menu a list of SQIs for the chosen branch is presented.

— Special Qualifications —

A (E) - Technical intelligence  
F (E) - Flying status  
O (E) - No special qualifications  
Previous Menu

When you leave the Special Qualifications menu the complete list of selected function choices is displayed for review.

Function Choices

- ✓ Takeoff and landing checks
- ✓ Hovering flight
- ✓ Takeoff and flight activities
- (done)

You may repeat the selection process to add functions associated with a different MOS, ASI or SQI. Repeating the selection process causes a horizontal menu containing Add, Start Over, and Cancel. Selecting Add allows you to work through the MOS, ASI, and SQI menus again, adding newly identified task/functions to the list. Selecting Start Over allows you to repeat the selection menus and **replace** the previously identified task/functions. Cancel will end the process and return to the third level menu.

---

Select from  
master list

This procedure allows you to select functions from the complete list in the master file. If a function list has already been generated, the Add/Start Over menu will be presented. If Add is chosen, then previously selected tasks will be highlighted and checked. If Start Over is chosen, then no functions will be highlighted or checked. Only selected (checked) items are included in current project analyses.

Function Choices

- ✓ Takeoff and landing checks
- ✓ Hovering flight
- Takeoff and flight activities
- Doppler navigation
- Approach and landing
- Weapons operation
- Degraded conditions/autorotation
- Tactical flight techniques
- Confined and pinnacle operations
- Emergency flight
- Weapons and emergency procedures
- (done)

---

Review  
selections

Review results of previous selection activities. All selected items are displayed on the screen along with a check mark. Items

can be removed from the list by selecting the item. The de-selected item will lose the check

Review Function Choices

/Takeoff and landing checks

/Hovering flight

(Done)

mark indicator. The item can be retained if it is selected again before leaving the menu. The de-selected item will be removed from the list when the menu is exited. (This is standard throughout the CFP-Aid system.)

---

## Enter/edit details

The Enter/edit details menu option presents the file Function Editor menu for the task/functions working file of the requirements data base. The Function Editor menu is shown here:

Function Editor

Edit

Add

Delete

The Function Editor menu allows you to edit specific records in the task/function working file. The menu presents three editing options that can be selected: Edit, Add, and Delete.

## Edit

The Edit option presents the complete list of records in the task/function working file. The working file contains only those task/functions selected for the current development and analysis exercise.

Edit Active Functions List

Takeoff and landing checks

Doppler navigation

Emergency flight

Weapons operations

. . . .

(more)

For each record selected an edit form will be displayed. The edit form presents the field variables and values for the selected records. A sample screen shows a form for editing.

## Task Function Information

|  |                               |
|--|-------------------------------|
| Description: Tactical flight techniques_____ |                               |
| Training Entry Level: __0.57                 | Training Standard: __0.63     |
| Classroom Hours: __0.40                      | Non-Equipment Hours: __0.30   |
| Equipment Hours: __0.70                      | Equipment Setup Hours: __0.10 |
| Other Equipment Costs: __0.00                |                               |

**Add**                      The Add option of the Function Editor menu presents a message screen explaining that adding records must be done via the master file routines.

**Delete**                      The Delete option presents a similar message. Deleting records from the working files is more correctly handled by eliminating the task/function from consideration by de-selecting it from the analysis list.

| Concept Formulation Process Aid |   |            |  |               |
|---------------------------------|---|------------|--|---------------|
| File                            | Requirements  | Components | Analyses   | Documentation |
|                                 | required Tasks/functions<br>requirement Categories<br>Simulation checklist<br>Enter/edit data |            | <b>Automatic selection</b><br>Select from master list<br>Review selections<br>enter/eDit details |               |

**Requirements Categories**                      Requirements Categories are classes of information required to learn to perform a function or task. They include visual, auditory, and motion cues to task performance, as well as feedback, such as force feedback on controls. The Requirements Categories procedure allows you to see, select or enter the cue and response requirements for the function choices. Your selections here are used later to make recommendations about component classes and options.

**Automatic selection**                      Automatically selects parameters based on links from selected functions. The automatically selected cue choices are displayed on the screen:

```

Review Automatic Cue Choices
✓ Visual - Airfield, runway, tower
✓ Motion - linear acceleration
✓ Auditory - normal engine noises
. . . . .
(done)

```

Cue choices may be deselected. Deselected choices will be removed from the analysis.

---

**Select from  
master list**

Allows you to select Requirement Categories or Cues from the master list. As before, if the cue categories have already been selected, you will be queried as to whether you wish to Add, Start Over, or Cancel the function. If you are adding to existing selections, then the requirement categories that are already selected will be highlighted and checked. All choices from the master list are displayed on the screen as shown here:

```

Cue Choices
✓ Visual - Airfield, runway, tower
✓ Motion - linear acceleration
✓ Auditory - normal engine noises
Auditory - weapons noises
. . . . .
(done)

```

---

**Review  
selections**

Review selections presents only the selected cue choices. Your previously selected cue choices, highlighted and checked, are displayed on the screen. Items can be deselected from this list and will be removed from the analysis.

```

Review Cue Choices
Visual - Airfield, runway, tower
✓ Motion - linear acceleration
✓ Auditory - normal engine noises
✓ . . . . .
(done)

```

---

**Enter/edit data**

The Enter/Edit data menu option presents the Cue Editor menu for master files in the Cue

database. It is through this menu option that you can Edit, Add, or Delete master records. The following sample screen presents the Cue Editor menu for the master cue database.

|   |
|---|
| Components Editor<br><b>Edit</b><br>Add<br>Delete |
|---|

The displays and operation of this function are the same as that described in the Main Enter/edit data in the Requirements menu (see below). Briefly, the edit will present a list of cues and allow selection for editing. The to-be-edited cue will appear on the screen with identified data fields. The add function will present the same screen with blank fields. After entering data, a series of screens will be presented that link the new cue to existing functions and components, and allow entry of instructional features and fidelity data for the cue. The delete function will present the list allowing selection of the to-be-deleted cue. When the cue is deleted the links to task/functions and components are removed also.

| Concept Formulation Process Aid |  |            |          |               |
|---------------------------------|--|------------|----------|---------------|
| File                            | Requirements   | Components | Analyses | Documentation |
|                                 | required Tasks/functions<br>requirement Categories<br><b>Simulation checklist</b><br>Enter/edit data |            |          |               |

#### Simulation Checklist

This option associates each task/function with indicators for simulation. Each task/function will be displayed in turn. The following sample screen shows two function characteristics selected for the Degraded Conditions/Autorotation.

FUNCTION: Degraded Conditions/Autorotation

Select all function characteristics appropriate

- ✓Task involves placing student and equipment in danger.
- ✓Task involves violating safety standards for actual equipment.

Trainee inexperience makes task unsafe.  
Task involves component failure that produces undue hazard.  
. . . . .  
Number of trials can be greatly increased with simulation  
(done)

For each task/function, you can select all applicable indicators for simulation. When you click on an indicator, a check mark will appear. You may remove a check mark by clicking on a checked indicator. When you select done the system links each checked indicator with the task/function for later analysis.

The system will repeat this display for each task/function. When you have selected all the appropriate indicators for each of the task/functions the system will ask you if you want to add the results to the outline. If you select No the links will not be added to the current outline. However, even if you elect not to add the results to the current outline, the links will continue to exist and will appear in the outline when you generate a new outline. If you select Yes the results will be appended to the current outline. If you select Replace your just completed selections of indicators for all the task/functions will be appended to the outline and all previous links for this module will be deleted from the current outline.

| Concept Formulation Process Aid |   |            |          |               |
|---------------------------------|---|------------|----------|---------------|
| File                            | Requirements  | Components | Analyses | Documentation |
|                                 | required Tasks/functions<br>requirement Categories<br>Simulation checklist<br>Enter/edit data |            |          |               |

**Enter/Edit Data** The Enter/Edit Data menu option presents the edit menu for master files in the requirements data base. It is through this menu option that you can edit any of the following master files:

MOS, ASI, SQI, task\function, and cues. The master edit menu is shown here:

```
— Select Data Type —
MOS
ASI
SQI
Task/function
Cues
```

The master edit menu presents the list of selectable master files for editing. When one of the master files is selected the edit menu for the selected file is then presented.

```
— MOS Editor —
Edit
Add
Delete
```

The edit menus allow you to edit specific records in the selected file. For each of the five selectable master data files listed above the same set of menu options is presented. Each menu presents three editing options that can be selected: Edit, Add, and Delete. The procedures for these three options are similar for all master files. Sample screens for editing an MOS(s) are presented below.

## Edit

The Edit option presents the complete list of records in the selected master file database. You are prompted to select any number of presented records for editing.

```
— MOS Edit Choices —
Aeroscout observer
Aviation, general
OH-58A/C scout pilot
. . . . .
(done)
```

For each record selected an edit form will be displayed. The edit form permits the field variables for the selected records to be changed. The following sample screen shows the edit form for an MOS record.



## MOS Table

MOS Description: Aeroscout Observer\_\_\_\_  
MOS ID: 93B\_

Branch: E

For MOSs there are only three fields, with the critical fields being MOS ID and Branch. The MOS ID should be the appropriate character string from AR 611. The branch is a letter that refers to one of the three levels in the Army: Enlisted, Warrant, or Officer.

### Add

The Add option of the edit menu presents a blank edit form (same as above) for the selected master file type. This form permits the field variables for a new record to be entered. If the record created does not match an existing record in the database you are asked to make the required associative links to other master file data bases.

For each required link a menu of all exiting records in that master file is presented. From this list you are prompted to select any number of records to be linked to the new record. For example, an MOS links to ASIs and each new ASI links to one or more task/functions.

The next menu will display Additional Skills that can be associated with the selected MOS. This will link the ASI to the MOS for selection.

Enter a C to continue, please.

Additional link categories are presented in turn. In this example, after the ASIs are selected a list of task/functions is presented for **each** ASI. These new links or associations are used in later analysis. The following example shows the sample list of ASIs to be linked to a new MOS record.

| Additional Skills |                             |
|-------------------|-----------------------------|
| 4A (E)            | - Reclassification training |
| P5 (E)            | - Master fitness trainer    |
| D1 (O)            | - AH-1H pilot               |
| . . . . .         |                             |
| (more)            |                             |

NOTE: The linking procedure is carried out for all necessary link associations. The following table identifies where links are made for each of the five master files. This table does not appear in the system.

| DB FILE           | LINKS TO                                |
|-------------------|---|
| MOS               | > ASI T/F <sup>a</sup>                  |
| ASI               | > MOS <sup>#</sup> SQI <sup>s</sup> T/F |
| SQI               | > T/F                                   |
| T/F <sup>x</sup>  | > ASI SQI CUES COMPONENTS               |
| CUES <sup>x</sup> | > T/F COMPONENTS                        |

<sup>a</sup> Linked to each replicated ASI.  
<sup>#</sup> MOS link is done by entering the MOS ID in the ASI record.  
<sup>s</sup> SQI link is based on the Branch code.  
<sup>x</sup> Instructional Feature and Fidelity data records are also created and linked to each record.

**Delete**                      The Delete option presents the complete list of records in the selected master file database. You are prompted to select any number of existing records for deletion. The selected records are deleted in both the master file and the master index file. The delete function also removes all links to the selected record. When done is selected or the last record is deleted from the index file the system returns to the Enter/Edit Data menu.

| MOS DELETE Menu      |
|----------------------|
| Aeroscout observer   |
| Aviation, general    |
| OH-58A/C scout pilot |
| . . . . .            |
| (done)               |

## Components Menus

|                                 |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| Concept Formulation Process Aid |              |            |          |               |
| File                            | Requirements | Components | Analyses | Documentation |

The Components module will assist you in specifying the Instructional Features and Fidelity required by the tasks/functions and to specify subsystem components for consideration. The instructional features and fidelity rule bases use data from the selected records to identify needed subsystem components. This information is used in conjunction with user identified or existing system data links to produce a set of recommended subsystem components.

|                                 |              |  |  |               |
|---------------------------------|--------------|--|--|---------------|
| Concept Formulation Process Aid |              |  |  |               |
| File                            | Requirements | Components   | Analyses   | Documentation |
|                                 |              | Instructional features<br>Fidelity<br>Select components<br>Enter/edit data | Automatic<br>auto with Confirm<br>answer Questions<br>Justify results<br>View results<br>enter/eDit detail |               |

### **Instructional Features**

The Instructional Features process uses an expert system rule base, which has been developed through research, to compute the benefit on a task-by-task basis for each available instructional feature. The rules may be examined (with great care) by using GURU functions outside of this system. The Instructional Features process is conducted using the following features:

---

#### **Automatic**

Automatically executes the Instructional Features rule base using the current data in the data base. The name of the function or cue and the name of the rule base is displayed while the rule base is working. If complete data is present in the record, no user interaction is required. If insufficient information is available in the data base to run the rule base, the system will ask you for additional information.

---

#### **Auto with confirm**

This Instructional Features rule base activation is similar to the automatic feature

above. In addition, the system displays the values assigned for the variables for each function. A sample table is shown here.

Task: Hovering flight

Rulebase: IFRB

— Select a variable to change

|  |           |
|--|-----------|
| What is the stage of learning on this task?      | -- Middle |
| Is the training development perf. standard high? | -- Yes    |
| Does this task deal with continuous movement?    | -- Yes    |
| . . . . .  |           |
| (Done)   |           |

To change the values in the variable table press ENTER or click on the variable, which will toggle through the available values. A separate table is presented for each selected task/function in turn. When the values provided for the questions are acceptable, clicking on "done" will make the system continue to the next rule base examination. If there are unanswered questions (marked as "unknown"), they will be superimposed on the questions table when "done" is selected. After these are answered, the next task/function will be addressed.

---

**Answer  
questions**

This feature runs the expert system rule base and requires answers to questions. For example, in the provided rule base, the first question asks you if the activities associated with the Function involve procedures, continuous movement, decision making and rule using, use of symbolic information, and/or voice communication. You select all activities that apply. This is an example with one activity selected:

Function: Approach and landing checks

What activities are  
involved in the task?

✓ procedures  
continuous movement  
perception  
d/making, r/using  
voice communication  
(done)

Other questions are in the following format:

Function: Approach and landing checks

Are discreet behaviors  
computer detectable?

Yes No

---

**Justify results** A list of all the selected tasks/functions that are linked to one or more instructional feature is presented on the screen for review.

Select one

Task: Hovering flight  
Task: Approach and landing checks  
Task: Degraded conditions/autorotation  
Done

When you select a task/function that requires instructional features, the system presents a list of all the instructional features followed by the justification for each. The justification describes the rules in the rule base that were used to recommend each instructional feature. A sample display is shown here:

Task: Hovering Flight                      Rulebase: IFRB

The following Instructional Features  
were selected:

|                         |                        |
|-------------------------|------------------------|
| Performance indicators  | Augmented feedback     |
| Total system freeze     | Remote graphics replay |
| Initial condition       | Crash override         |
| Reset and/or reposition | Parameter freeze       |
| . . . . .               | . . . . .              |

If the task involves continuous movement, procedures, decision making/rule using, or voice communication, and discrete behaviors are not computer detectable then performance indicators are needed.

Continue

This display will remain on the screen until you press ENTER or click the mouse.

---

**View data**

This process displays a graph showing the number of functions for which each instructional feature was recommended. The instructional features are identified by the first two letters of their names. The mouse will not exit this screen, as with all graphs in the system, ENTER is required.

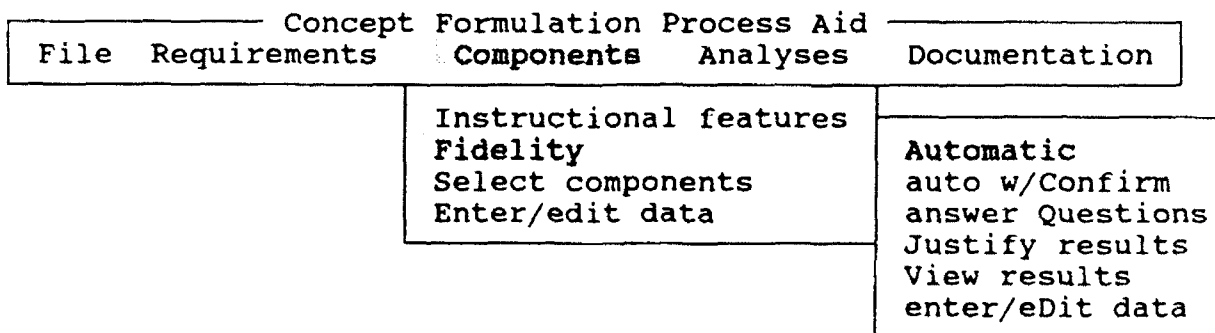
---

**Enter/Edit data**

The Enter/Edit menu allows you to edit specific records in the instructional feature master data base. This data base retains information about the instructional features. The menu presents two editing options: Edit or Add. The procedures for these three options are the same as presented before. The editing menu looks like this:

```
IF Detail Editor
Edit
Add
```

The error checking and linking functions are similar to those used in the Requirements menu described previously. Instructional Features are linked only to components.



**Fidelity**

The Fidelity process continues the training-device trade-off determination process begun with the Instructional Features process. The goal of the Fidelity process is to specify the

levels of fidelity needed for effective training of the task/function.

Currently, the Fidelity process can be conducted for Motion and Visual cues. The current system structure allows for other fidelity rule bases to be added as they are developed. The Fidelity process provides the following functions:

---

**Automatic**

Automatically runs the Fidelity rule base using the results of the Requirements Module and the Instructional Features process. While the automatic feature is operating, the screen displays the name of the rule base being run (e.g., MOTION) and the name of the task/function, cue, or instructional feature being run against the rule base. While the rule base is being run the system may ask you for additional information. Questions are asked only if the system can not find all the information needed to satisfy all parts of the rule base. Examples of questions asked are shown in Answer Questions below.

---

**Auto with confirm**

This feature executes the Fidelity rule base in a fashion similar to the automatic with confirm used in the Instructional Feature identification, above. The system lists the input data for each feature or task so you can confirm the variables for each item. To change the values in the variable table press ENTER or click on the variable to toggle through the available values. Some of the values may be marked unknown and not toggle in response to click or enter. These questions require numerical input, which cannot be input on this screen. The system assumes that unknown = 0 for these questions. If these values are incorrectly marked, the data can be edited for permanent entry, or the "Answer Questions" routine (see below) can be used to investigate the effect of different values on system recommendations. A sample table is shown below. When finished toggle the "done" line.

Task: Hovering flight

Rulebase: MOTION

```
— Select a variable to change
Is there a motion cue involving sway?      -- No
Is there a motion cue involving pitch?     -- Yes
Is there an emergency cue involving sway?  -- No
. . . . .
(Done)
```

---

**Answer  
Questions**

This feature runs the rule bases and asks you questions. For example, the following kinds of questions may be presented:

Task: Hovering flight

Rulebase: MOTION

Check the high or moderate magnitude motion cues.

```
lateral acceleration
vertical acceleration
longitudinal accel
/yaw
/pitch
/roll
(done)
```

Task: Hovering flight

Rulebase: MOTION

Which cues are NOT correlated with visual cue?

```
yaw
pitch
roll
(done)
```

---

**Justify results**

The justify results process lets you review the rule base justification of each selected fidelity dimension for any of the task/functions, cues, or instructional features you have included in the project. You will first see the task selection list:



Select one  
**Task: Hovering flight**  
 Task: Takeoff and landing checks  
 . . . . .  
 Done

When you select a task the screen displays the task name, the rule base in use, the Fidelity dimensions selected, and the justification rationale. The results remain on the screen until you press a key or click the mouse. The system steps through each identified fidelity dimension. A sample screen is shown here:

Task: Hovering flight                      Rulebase: MOTION

The following Fidelity dimensions were selected:

G seat

Platform motion is required to represent "sway" and "yaw" cues. If these are not present, or if they are correlated with other cues, then the required motion may be best provided with seat motion.

Continue

---

|                     |   |
|---------------------|---|
| <b>View results</b> | Displays a graph showing the level (count) of fidelity called for by each Fidelity dimension. |
|---------------------|---|

---

|                        |  |
|------------------------|--|
| <b>Enter/edit data</b> | The Enter/Edit menu allows you to edit specific records in the Fidelity Dimension Master Database. This data base retains information about the Fidelity dimensions and levels. The menu presents two options, as shown below. |
|------------------------|--|

Fidelity Editor  
**Edit dimensions**  
 Add dimensions

The error checking and linking functions are the same as those used previously. Adding a fidelity dimension allows the new dimension to

be linked to components, so that when this feature is recommended, the components will automatically be selected.

| Concept Formulation Process Aid   |              |  |          |               |
|---|--------------|--|----------|---------------|
| File  | Requirements | Components   | Analyses | Documentation |
| Automatic selection<br>Select from master list<br>Review selections<br>enter/eDit details |              | Instructional features<br>Fidelity<br>Select components<br>Enter/edit data |          |               |
|   |              |  |          |               |

#### Select Components

The Select Components process takes as input a set of candidate subsystem components for the set of tasks/functions, cues, instructional features, and fidelity dimensions.

The Select Components process uses the following activities:

#### Automatic selection

The automatic selection uses the results of Tasks/Functions, Cue, Fidelity, and Instructional Features. This selection includes all components that are linked to selected functions, cues, and instructional features, or fidelity levels. The components, organized into families (e.g., AURAL, MOTION), are displayed on the screen for review. You may deselect any items you do not want included.

| Review Automatic Component Choices |                                   |
|------------------------------------|-----------------------------------|
| ✓ AUDIO                            | -- Sound generator                |
| ✓ IM GEN                           | -- Computer generated imagery-med |
| ✓ IM GEN                           | -- Videodisc image generation     |
| ✓ PLAT MOT                         | -- 3-dof platform motion          |
| (Done)                             |                                   |

#### Select from master list

This option allows you to choose components from the master list. If you are adding to existing devices, then the components that are already selected will be highlighted and checked.

```

Review Automatic Component Choices
✓ AUDIO  -- Sound generator
IM GEN  -- Computer generated imagery-lo
✓ IM GEN  -- Computer generated imagery-med
IM GEN  -- Computer generated imagery-hi
✓ IM GEN  -- Videodisc image generation
INST MGT-- Course management computer
INST STA-- Instructor/operator station
✓ PLAT MOT-- 3-dof platform motion
. . . . .
(Done)

```

This list shows four items selected (checked) from the master list. Only selected items will be considered as a part of the project.

---

#### Review selections

Allows you to review the list of items that have been selected. You may deselect any item.

```

Review Component Choices
✓ AUDIO  -- Sound generator
✓ IM GEN  -- Computer generated imagery-med
✓ IM GEN  -- Videodisc image generation
✓ PLAT MOT -- 3-dof platform motion
(Done)

```

---

#### Enter/Edit details

The Enter/Edit menu allows you to edit specific records in the Master Component Database. The menu presents the standard three editing options: Edit, Add, and Delete. The procedures for these three options are the same as presented before. The editing menu looks like this:

```

Component Editor
Edit
Add
Delete

```

The error checking and linking functions are the same as those used in the Requirements menu described previously.

## Analyses Menus

| Concept Formulation Process Aid |              |            |                 |               |
|---------------------------------|--------------|------------|-----------------|---------------|
| File                            | Requirements | Components | <b>Analyses</b> | Documentation |

The Analyses module conducts or supports the cost, effectiveness, technical risk and schedule (CERS) analyses for specific components and systems based on your previous selections and input.

| Concept Formulation Process Aid |              |   |                 |  |
|---------------------------------|--------------|---|-----------------|--|
| File                            | Requirements | Components  | <b>Analyses</b> | Documentation  |
|                                 |              | <b>Cost comparison</b><br>Effectiveness comparison<br>Technological comparison<br>Schedule comparison<br>Overall comparison |                 | <b>Component CERS</b><br>cReate system<br>System CERS<br>Enter/edit data |

**Component CERS** You conduct component CERS tradeoffs using the following features. The features all work from similar screens and in the same fashion, drawing from different sections of a spreadsheet.

---

**Cost comparison** Allows you to compare component cost for all components within each family. When you select this option the screen lists the component families.

Component cost comparison  
Component family

|   |
|---|
| IM GEN<br>PLAT MOT<br>VIS DISP<br>AUDIO<br>Done |
|---|

When you select a component family the screen displays a menu showing the Low, Expected (most likely), and High cost values for each previously selected component in the family. Also, the menu allows you the option to view the cost data in graph form or in a

spreadsheet. A sample menu for component costs is shown here:

| Component costs                           |                              | Low  | Exp  | High |
|---|------------------------------|------|------|------|
| <input checked="" type="checkbox"/>       | Computer generated imagery-m | 1000 | 2000 | 3000 |
| <input checked="" type="checkbox"/>       | Videodisc image generation   | 300  | 500  | 800  |
| Graph component costs                     |                              |      |      |      |
| Show spreadsheet of component information |                              |      |      |      |
| Return to component family menu           |                              |      |      |      |

This menu lists all selected components including those based on function and cue links as well as those selected through rule base operations. All listed components are checked. The check mark indicates which of the listed components will be included in the graph when you select the graph option. Click on a component to remove the check. Deselected items are not deleted from the system; they just do not appear in the graph.

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the component family menu by choosing the "return" line at the bottom and choose another component family. You may deselect components and view the results of the de-selection in a graph.

The graph option presents the component cost range for each component in the component family. You must use ENTER to leave the graph as the mouse is inactive on this screen.

The spreadsheet option presents the cost data for each component in the component family by cost category. Deselected items will be shown in the spreadsheet. A sample portion of a spreadsheet is shown here.

# Component R&D Cost Comparison

Type "\BYE<enter> to exit spreadsheet

|                             | Comput<br>er gen | Videor<br>image |
|-----------------------------|------------------|-----------------|
| Cost (\$K):                 |                  |                 |
| R&D cost adjustment factor  | 1.00             | 1.00            |
| R&D low estimate            | 200.00           | 100.00          |
| . . . . .                   |                  |                 |
| Technical risk              | 0.30             | 0.20            |
| R&D schedule (months)       |                  |                 |
| R&D sched adjustment factor | 1.00             | 1.00            |

The data entry portion of the spreadsheet scrolls allowing you to move to any data cell. Use the arrow, PgUp, and PgDn keys to move while in the spreadsheet. You may make changes by highlighting a cell, typing a number, and pressing ENTER. When you leave the spreadsheet your changes will be written to the data base.

**WARNING:** The only way to leave the spreadsheet is using the \BYE command. While in the spreadsheet, only enter numbers in a blank cell or change a number in a cell. Care should be taken not to attempt any other changes to the spreadsheet as this may cause the program to malfunction.

## Effectiveness comparison

This option allows you to compare component effectiveness for each component family. The effectiveness of a component is measured by the number of links to that component. When you select this option the screen lists the effectiveness component family. A sample screen is shown here:

Component effectiveness comparison  
Component family

```

IM GEN
PLAT MOT
VIS DISP
AUDIO
Done
    
```

When you select a component family a menu is displayed showing the effectiveness for that component family. The menu shows the number of tasks, cues, instructional features, and fidelity dimensions for each selected component in the family. A sample menu for component effectiveness is shown here:

| Requirements Satisfied                    | -Tsks- | Cues- | IFs- | Fids- |
|---|--------|-------|------|-------|
| ✓ Computer generated imagery              | 4      | 1     | 0    | 1     |
| ✓ Videodisc image generation              | 3      | 1     | 0    | 0     |
| Graph component effectiveness             |        |       |      |       |
| Show spreadsheet of component information |        |       |      |       |
| Return to component family menu           |        |       |      |       |

**WARNING:** If there are all zeros under Tasks, Cues, IFs, and Fids for any component in any family the system creation routines will produce anomalous results. The only way to ensure that a value is assigned to the component for effectiveness is by: 1) ensuring that there is at least one link in the database between the component and a task/function or cue, OR 2) ensuring that either the fidelity or the instructional rulebase assigns a fidelity dimension or instructional feature to the component. The first may be done through adding task/functions or cues to the requirements list that are related to the component. The second may be accomplished by exercising the rule bases. If there still is no entry in one of the four columns, revert to the Components menu, Select components submenu, and use Review selections to remove that component. That component probably should be removed at that point because there is no overt evidence of it being needed.

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the component family menu using the "return" option and choose another component family. You may deselect components and view the results of the de-selection in the graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents the number of requirements satisfied for each component in the component family. When you leave the graph you return to the Requirements Satisfied menu.

When you return to the menu you can select or deselect any of the components listed.

The spreadsheet option presents the cost data for each component in the component family by cost category as described above. You may make changes to the data in the spreadsheet. When you leave the spreadsheet your changes will be written to the data base.

---

**Technological  
comparison**

This option allows you to compare component developmental technical risk for each component family. When you select this option the screen lists the component family. A sample screen is shown here:

Component technical risk comparison  
Component family

IM GEN  
PLAT MOT  
VIS DISP  
AUDIO  
Done

When you select a component family a menu is displayed showing the technical risk for each component in that component family. A sample table for component risk is shown here:

| Component Technical Risk                  | Risk |
|---|------|
| ✓ Computer generated imagery-med          | 0.10 |
| ✓ Videodisc image generation              | 0.20 |
| Graph component technical risk            |      |
| Show spreadsheet of component information |      |
| Return to component family menu           |      |

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the component family menu and choose another component family. You may deselect components and view the results of the de-selection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.



The graph option presents the range of technical risk for each component in the component family. When you leave the graph you return to the Component Technical Risk menu. When you return to the menu you may select or deselect any of the components listed.

The spreadsheet option presents the technical risk data for each component in the component family by cost category. When you leave the spreadsheet your changes are written to the data base.

---

**Schedule  
comparison**

This option allows you to compare component schedule for each component family. When you select this option the screen lists the component family. A sample screen is shown here:

Component schedule comparison  
Component family

IM GEN  
PLAT MOT  
VIS DISP  
AUDIO  
Done

When you select a component family a menu is displayed showing the component schedule for that component family. The menu shows the Low, Expected, and High schedule risk values for each selected component. The risk values are expressed in terms of months to develop the component. A sample menu, with two components selected, is shown here:

| Component                        | Schedule | Risk | Low | Exp | High |
|----------------------------------|----------|------|-----|-----|------|
| ✓ Computer generated imagery-med | 24       | 30   | 48  |     |      |
| ✓ Videodisc image generation     | 12       | 15   | 18  |     |      |

Graph component costs  
Show spreadsheet of component schedule  
Return to component family menu

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the component family menu and choose

another component family. You may deselect components and view the results of the deselection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents the range of component schedule for each component in the component family. When you leave the graph you return to the Component Schedule Risk menu. When you return to the menu you may select or deselect any of the components listed.

The spreadsheet option presents the schedule data for each component in the component family by cost category. When you leave the spreadsheet your changes are written to the data base.

---

**Overall  
comparison**

This option allows you to compare the components within a family across all factors of the CERS. When you select this option a menu is displayed showing the component families. When you select a component family, a menu similar to the sample shown here is displayed.

Component Overall Comparison

✓ Computer image generation-med

✓ Videodisc image generation

Graph component costs

Show spreadsheet of component information

Return to component family menu

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the component family menu and choose another component family. You may deselect components and view the results of the deselection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents four graphs, in quadrants; one graph for each of the four parts of the CERS for that component family. When you leave the graph you return to the Component Overall Comparison menu. When you return to

the menu you can select or deselect any of the components listed.

The spreadsheet option presents the component CERS overall comparison data. Here to you may make changes to the data and when you leave the spreadsheet your changes are written to the data base.

| Concept Formulation Process Aid  |              |            |   |               |
|--|--------------|------------|---|---------------|
| File   | Requirements | Components | Analyses  | Documentation |
| Automatic system creation<br>Select from master list<br>Review system components |              |            | Component CERS<br>cReate system<br>System CERS<br>Enter/edit data |               |

**Create Systems**      This process creates systems from your preselected components.

---

**Automatic system creation**      This option creates systems automatically from the identified component selections and displays a list of the systems generated. Caution should be used with this option as it multiplicatively generates all possible systems that can be formed by combining the selected components. If there are many components selected, or many possible families, automatic system creation will produce a large number of systems, perhaps in the thousands. For example, three options each in seven families will produce 2,187 candidate systems. In most cases, it is probably best to create systems using the Select from master list options. Limiting the options to two per family in the example would reduce the number of candidate systems generated to 128. Restricting the components to one choice in a few families (two for example) would reduce the number of candidates further, to 32. A sample display of automatically created systems is shown here.

Name Automatic System Choices

1. Candidate system  
2. Candidate system  
.  
.  
.  
.  
.  
Done

Automatic system creation labels the systems as shown above. You should then give meaningful names to the systems. To name a system, select one of the systems from the menu. The system will show the components included in the system and ask for a name in the display shown below:

2. Candidate system \_\_\_\_\_ contains the following components:  
Computer generated imagery-med                      3-dof platform motion  
Helmet display

Enter the new system name:

2. Candidate system \_\_\_\_\_

Type over the assigned label to enter your preferred name (e.g., #2 Med CGI, 3-dof, Helmet system) and press ENTER. Continue this process to rename the remaining systems as you desire.

When you select done the review menu is displayed showing each candidate system. All your new titles will be included.

Select from  
master list

You may select components for a candidate system from a master list. You are shown a series of menus; one menu for each component family (e.g., IM GEN, PLAT MOT, VIS DISP, AUDIO). Each menu lists the components in that family. A sample menu is shown here.

IM GEN

Computer generated imagery-low cap  
Computer generated imagery-med cap  
Computer generated imagery-SOTA  
Videodisc image generation  
None

From each component family menu, you select one item for your candidate system. If you do not want to include a listed component, select None. When you select an item the next menu in the series is displayed.

When you have responded to each of the menus in the series you are asked if you want to add another system.

Do you want to add another system,  
or are you finished?

Another Finished

Select Another to repeat this process and choose the components for another candidate system. When you select Finished The screen displays a list of candidate systems.

```
Name Automatic System Choices
#2 Med CGI, 3DOF, Helmet
1763. Candidate system
Done
```

This list shows each system with a number representing the chronological order in which they were specified followed by a generic name. This display allows you to review the components you specified for each system and give meaningful names to each of the candidate system. This is the only menu that allows re-naming candidate systems.

When you select Done a review screen appears:

```
Review System Choices
✓ #1 Platform motion helmet display system
✓ #2 Seat motion videodisc helmet system
Done
```

In the Review System Choices menu you may review all current systems and deselect any you want to remove from consideration.

---

#### Review system choices

When you select Review system components you see a list of all current candidate systems. A sample list is shown here.

```
Review System Choices
✓ #1 Platform motion helmet display system
✓ #2 Seat motion videodisc helmet system
Done
```

In this Review System Choices menu, you may review all current systems and deselect any you want to remove from consideration. Select Done to return to the previous menu.

| Concept Formulation Process Aid  |              |            |   |               |
|--|--------------|------------|---|---------------|
| File   | Requirements | Components | Analyses  | Documentation |
| <b>R&amp;D Cost comparison</b><br>Effectiveness comparison<br>Technological comparison<br>Schedule comparison<br>Overall comparison<br>Lifecycle cost comparison |              |            | Component CERS<br>cReate systems<br><b>System CERS</b><br>Enter/edit data |               |
|  |              |            |   |               |

### System CERS

This menu provides the functions for conducting system tradeoffs. The system CERS analyses are combined over components. The costs are summed across components; the effectiveness considers all the functions, cues, fidelity, and instructional features linked to all system components; risk is combined as a probability of failure; and schedule is combined by considering the longest component schedule. You can edit the estimates and weights for the system CERS in a spreadsheet as done before with component CERS. You can view the results in graphs.

### R&D Cost comparison

Allows you to compare system R&D cost across component families. When you select this option the screen displays a menu showing the Low, Expected, and High cost values for each selected system. Also, the menu gives you the option to view the cost data in graph form or in a spreadsheet. A sample menu for system costs is shown here:

| System R&D Costs                       |                        | Low  | Exp  | High |
|--|------------------------|------|------|------|
| ✓ #1                                   | Platform motion system | 1000 | 2000 | 3000 |
| ✓ #2                                   | Seat motion system     | 300  | 500  | 800  |
| Graph system R&D costs                 |                        |      |      |      |
| Show spreadsheet of system information |                        |      |      |      |
| Return to system CERS menu             |                        |      |      |      |

You may move back and forth between this menu, the graph, and the spreadsheet or return to the system CERS menu. You may deselect systems and view the results of the de-selection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents the system R&D cost range. When you leave the graph you return to the System R&D Costs menu. When you return to the menu you can select or deselect any of the systems listed.

The spreadsheet option presents the cost data for the selected systems. A sample portion of a spreadsheet is shown here.

#### System R&D Cost Comparison

Type "\BYE<enter> to exit spreadsheet

|                                | Seat<br>motion | Platform<br>motion |
|--------------------------------|----------------|--------------------|
| Cost (\$K):                    |                |                    |
| R&D cost adjustment factor     | 1.00           | 1.00               |
| R&D low estimate               | 200.00         | 100.00             |
| . . . . .                      |                |                    |
| . . . . .                      |                |                    |
| Technical risk                 | 0.30           | 0.20               |
| R&D schedule (months)          |                |                    |
| R&D schedule adjustment factor | 1.00           | 1.00               |

The data entry portion of the spreadsheet scrolls allowing you to move to any data cell. You may make changes by highlighting a cell, typing a number, and pressing ENTER. When you leave the spreadsheet your changes will be written to the data base. NOTE: As before, \BYE<enter> is required to exit the spreadsheet.

---

#### Effectiveness comparison

This option allows you to examine the effectiveness of each candidate system. The values represent the number of tasks or cues that the system addresses. When you select this option a menu is displayed showing the effectiveness of the candidate systems. A sample menu is shown here:

|  |   |
|--|---|
| System Effectiveness                   |   |
| ✓ #1 Seat motion system                | 8 |
| ✓ #2 Platform motion system            | 3 |
| Graph system effectiveness             |   |
| Show spreadsheet of system information |   |
| Return to system CERS menu             |   |

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the system CERS menu. You may deselect systems and view the results of the de-selection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents the range of effectiveness for the candidate systems. When you leave the graph you return to the System Effectiveness menu. When you return to the menu you may select or deselect any of the components listed.

The spreadsheet option presents the effectiveness data for each candidate system. When you leave the spreadsheet your changes are written to the data base.

---

#### Technological comparison

This option allows you to compare system technical risk for each system. When you select this option a menu is displayed showing the technical risk for each system. A sample menu for system technical risk is shown here:

|  |  |      |
|--|--|------|
| System Technical Risk                  |  | Risk |
| ✓ #1 Seat motion system                |  | 0.10 |
| ✓ #2 Platform motion system            |  | 0.20 |
| Graph system technical risk            |  |      |
| Show spreadsheet of system information |  |      |
| Return to system CERS menu             |  |      |

You may move back and forth between this menu, the graph, and the spreadsheet. You may also return to the system CERS menu. You may deselect systems and view the results of the de-selection in a graph. De-selected items are not deleted from the system; they just do not appear in the graph.



The graph option presents the range of technical risk for each system. When you leave the graph you return to the System Technical Risk menu. When you return to the menu you may select or deselect any of the components listed.

The spreadsheet option presents the technical risk data for each candidate system. When you leave the spreadsheet your changes are written to the data base.

---

**Schedule  
comparison**

This option allows you to compare system schedule for each candidate system. When you select this option the screen displays a menu showing the system schedule risk. The menu shows the Low, Most Likely, and High schedule risk values for each system. A sample menu, with two components selected, is shown here:

| System R&D Schedule                    |                        | Low | Exp | High |
|--|------------------------|-----|-----|------|
| ✓ #1                                   | Seat motion system     | 24  | 30  | 48   |
| ✓ #2                                   | Platform motion system | 12  | 15  | 18   |
| Graph system schedules                 |                        |     |     |      |
| Show spreadsheet of system information |                        |     |     |      |
| Return to system CERS menu             |                        |     |     |      |

You may move back and forth between this menu, the graph, and the spreadsheet or return to the system CERS menu. You may deselect systems and view the results of the de-selection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents the range of schedule for each system. When you leave the graph you return to the System Schedule Risk menu. When you return to the menu you may select or deselect any of the components listed.

The spreadsheet option presents the schedule data for each system cost category. When you leave the spreadsheet your changes are written to the data base.

---

**Overall  
comparison**

This option allows you to compare the overall comparison for each system. This comparison is

across all components of the system CERS. When you select this option, a menu similar to the sample shown here is displayed.

System Overall Comparison

- ✓ #1 Seat motion system
- ✓ #2 Platform motion system

Graph overall comparison

Show spreadsheet of overall comparison

Return to system CERS menu

You may move back and forth between this menu, the graph, and the spreadsheet or return to the system CERS menu. You may deselect systems and view the results of the de-selection in a graph. Deselected items are not deleted from the system; they just do not appear in the graph.

The graph option presents four graphs, in quadrants; one graph for R&D Costs, one for Effectiveness, one for Technical Risk, and one for R&D schedule risk. Effectiveness comparison is not shown. When you leave the graph you return to the System Overall Comparison menu. When you return to the menu you can select or deselect any of the components listed.

The spreadsheet option presents overall system R&D cost comparison data. Here to you may make changes to the data and when you leave the spreadsheet your changes are written to the data base.

---

**Life cycle cost comparison**

This option allows you to make life cycle cost comparisons for each candidate system. When you select this option the screen displays a menu showing the system generated name, or the name you gave each system, for all the systems generated in the current project. A sample menu is shown here.

|  |
|--|
| Life Cycle Cost Comparison<br>✓ #1 Platform motion system<br>✓ #2 Seat motion system<br>Graph life cycle costs<br>Show spreadsheet of life cycle costs<br>Return to system CERS menu |
|--|

The options available in this display are the same as those described above.

| Concept Formulation Process Aid |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| File                            | Requirements | Components | Analyses | Documentation |

|   |
|---|
| Component CERS<br>cReate system<br>System CERS<br>Enter/edit data |
|---|

**Enter/edit data** Maintain System master files. These functions are not programmed in the current version.

#### Documentation Menus

| Concept Formulation Process Aid |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| File                            | Requirements | Components | Analyses | Documentation |

The Documentation module (a) generates an outline that documents your work on the project, (b) lets you edit the outline template, (c) print s the outline, and (d) allows you to save the outline text in an ASCII format in a file. The ASCII file can be edited with most word processing systems.

| Concept Formulation Process Aid |              |            |          |               |
|---------------------------------|--------------|------------|----------|---------------|
| File                            | Requirements | Components | Analyses | Documentation |

|   |
|---|
| Generate outline<br>Edit template<br>Print Outline<br>Print to file |
|---|

#### **Generate Outline**

This process generates an outline based on the results of all analyses. The outline covers all required materials for developing the Trade-Off Determination (TOD) document. The generated outline replaces existing information with current functions, requirement categories, components, etc. In other words, this routine takes all the working databases, as they

currently exist, and generates information for the TOD outline.

**NOTE:** If you were saving the outline as an audit trail of the analysis process, you should either save the project to a file (using the routines in the File module) or print the old outline (see below) before you generate a new outline.

---

#### Edit template

This selection allows you to edit the outline template. A sample display for the edit screens are shown here.

Select an outline entry to edit \_\_\_\_\_

1.0 INTRODUCTION

1.1 Purpose

1.2 Requirements

1.3 Simulation Need

1.4 Required System Capabilities

. . . . .

(more) \_\_\_\_\_

When you select an outline entry to edit (e.g., Purpose) the edit screen is displayed.

What is the paragraph designator? 1.1

What is the paragraph title?  
Purpose

First, type in a new paragraph designator (outline line number). Then type in the name of the new subparagraph or the new name for the existing paragraph number. When you enter the name and press ENTER the Select modules menu is shown.

Select modules \_\_\_\_\_

Function/Task

✓Requirements categories

✓Simulation checklist

. . . . .

. . . . .

(done)

This sample menu shows two modules selected. This means that all the results of activities in the two selected modules will be added as

outline entries under the new or edited outline designator.

---

|                      |   |
|----------------------|---|
| <b>Print outline</b> | This selection sends the <u>current</u> outline to the printer. |
|----------------------|---|

---

|                      |   |
|----------------------|---|
| <b>Print to file</b> | This process saves the current outline text to a text file. The text file is saved to a file named OUTLINE.PRN located in the project subdirectory. Be sure to use DOS procedures to rename the text file, using a unique file name, prior to saving another version of the outline. Otherwise, the system will over-write the file and the information will be lost. |
|----------------------|---|

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